

Risk analysis in aquaculture – experiences from small-scale shrimp farmers of India

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ABSTRACT

The Network of Aquaculture Centers in Asia and the Pacific (NACA), in association with the Marine Products Export Development Authority (MPEDA) has been implementing a collaborative programme for the last several years to support shrimp farmers in India to adopt better management practices (BMPs) for disease control, coastal management and sustainable farming. This programme was started with a longitudinal epidemiological study to identify hazards (disease, food safety, social, environmental and financial) and

assess risks in small-scale shrimp farms in Andhra Pradesh (2000–2001). The “risk factors” identified using epidemiological tools provided an understanding of the disease causation and possible risk management options (i.e. BMPs) for reducing the likelihood of shrimp disease outbreaks and low pond productivity. Formulation of BMPs was followed by a village demonstration programme (2003–2006) that successfully organized small-scale farmers into self-help groups for adoption of BMPs. The success of the village demonstration programme generated considerable enthusiasm among the aquaculture farming community, and there are now more requests from many quarters for conducting such programmes in the different regions of India. As a result, aquaclubs/aquaculture societies have been established in the maritime states for reducing disease risks and effective communication of risk management strategies with a participatory approach. In order to sustain the work initiated by the MPEDA-NACA project and provide a thrust to sustainable aquaculture development, MPEDA has established a separate agency – the National Centre for Sustainable Aquaculture aimed to provide technical support to the primary aquaculture societies and build capacity among small farmers to reduce risks and to produce quality shrimp in a sustainable manner. Although the programme was carried out in five coastal states of India (Andhra Pradesh, Tamilnadu, Gujarat, Karnataka and Orissa), the findings have wider application to other coastal shrimp farming areas in India.

BACKGROUND

The Network of Aquaculture Centers in Asia and the Pacific (NACA) in association with the Marine Products Export Development Authority (MPEDA) has been involved in supporting small-scale shrimp farmers in India to adopt better management practices (BMPs) for shrimp disease control, improved management of coastal environments and sustainable farming. The initial work was not formally planned to follow the risk analysis (RA) approach, but the approach adopted eventually mirrored some of the requirements of a more formal risk analysis, and the experiences may provide valuable lessons in the application of risk analysis in small-scale aquaculture farming.

The aim of the MPEDA/NACA project was to develop strategies for reducing the risk of shrimp disease outbreaks and improve farm productivity through formation of “aquaclubs” (cluster, farmer self-help groups) to tackle shrimp disease problems more effectively. The demonstration programmes were successful in organizing small-scale farmers into self-help groups for adoption of BMPs. The demonstration of risk management practices in cluster farms gave promising results, with improvements in both profits and productivity during the period of demonstrations. In farms adopting better shrimp health management recommendations, returns shifted from a loss in 80 percent of the ponds to a profit in 80 percent of the ponds, a good indication of the viability of the management measures resulting from the study. The success has now led to an increasingly wide application of the approach in India and elsewhere in Asia.

HAZARD IDENTIFICATION AND RISK ASSESSMENT

The MPEDA/NACA collaboration started with the conduct of a longitudinal epidemiological study to identify hazards (disease: horizontal and vertical transmission of diseases in selected shrimp farming areas, including investigation of hatcheries and broodstock, food safety, social, environmental and financial aspects) and assess risks of key hazards in small-scale shrimp farms in Andhra Pradesh during 2000–2001. The epidemiological study, which covered a total of 385 ponds in two districts of Andhra Pradesh, identified the hazards (or “what can go wrong”) at the farm level as (a) shrimp disease outbreaks and (b) low pond productivity, for further analysis. The risk of the occurrence/impact associated with these hazards was then analyzed using an epidemiological approach, and a range of risk factors were identified (e.g. presence of

whitespot syndrome virus (WSSV) in shrimp seed, shrimp pond depth, soil conditions, etc.) that were significantly associated with these outcomes. Using epidemiological analysis, these “risk factors” provided an understanding of white spot disease (WSD) causation and possible risk management options for reducing the likelihood of shrimp disease outbreaks and low pond productivity.

In aquaculture systems, a risk factor is a crop-related factor that simply increases or decreases the probability of occurrence of an adverse event happening during a specified time period. For example, WSD is an adverse event during the shrimp-cropping period. If a high prevalence of WSSV in seed batches stocked in ponds increases the probability of occurrence of WSD, then the high prevalence of WSSV in seed batches is called a risk factor to WSD. Epidemiology investigates the statistical and biological significance of the relationship between the adverse event and the hypothesized risk factor to determine whether the hypothesized risk factor is a risk factor or not. The risk factor study of the MPEDA/NACA project considered shrimp disease outbreak and poor production as adverse crop events for the epidemiological analyses.

In total, the study covered 365 ponds in the state of Andhra Pradesh (MPEDA/NACA, 2003). The ponds were selected randomly. WSSV has been established as the “necessary cause” of WSD. However, presence of the necessary cause alone will not lead to a WSD outbreak in a pond. In a farm situation, a number of “component causes” (risk factors) along with the “necessary cause” might become “sufficient cause” to produce WSD outbreaks. The MPEDA/NACA study clearly shows that WSD is not caused by any one factor. Rather a number of risk factors influence the occurrence of WSD in the farm. These risk factors occur throughout the shrimp cropping cycle and in general terms, fall into the following categories during the different stages of the crop cycle:

- season of stocking;
- pond preparation;
- pond filling and water preparation;
- seed quality and screening;
- water management;
- pond bottom management;
- feed management; and
- disease treatments.

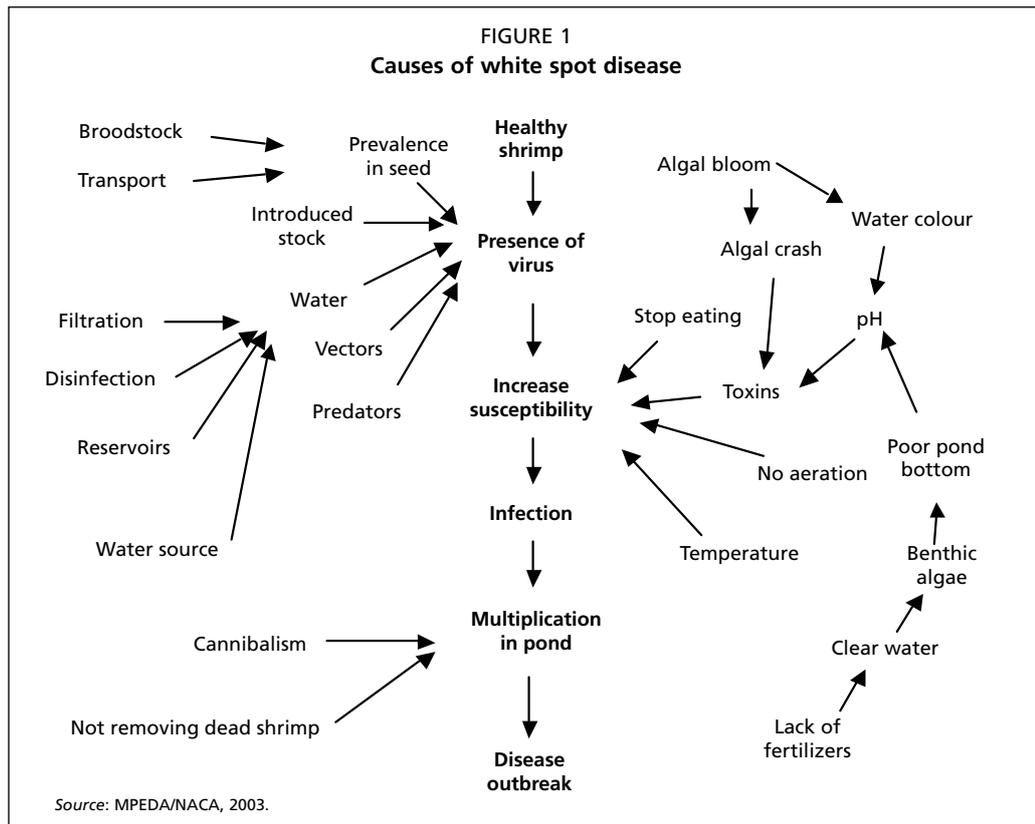
The risk factors at each stage of the cropping cycle and their relationship to WSD outbreaks are illustrated below in a “web of disease causation” in Figure 1.

The following summarize the main points shown in the “web”:

- A WSD outbreak is the end result of a series of actions or changes from healthy shrimp through to disease outbreak.
- At each stage of the cropping cycle, a number of factors influence the development of the disease in individual animals and also in the population of shrimp in each pond.
- WSSV can enter the shrimp and pond through different routes, including shrimp seed, water, carrier animals and transfer of infected animals and farm equipment from one farm to another.
- Adverse environmental factors combined with a high prevalence of infected shrimp among the pond population are necessary for a mass disease outbreak to occur.

Management factors can be used to control environmental factors and reduce risks of WSD occurring in the pond. To be successful in controlling shrimp disease, one has to manage all potential risks at different stages of the cropping cycle.

The results from the shrimp disease risk factor study clearly show a number of significant factors that influence shrimp disease outbreaks and shrimp yields at the pond level, many of which can be managed at the farm level. The risk factor study



clearly demonstrates that WSD is not caused by any one factor but by a number of factors that interact and influence the occurrence of the disease. Thus, an integrated management and extension approach is necessary to deal with the key factors that contribute to disease occurrence.

The findings provide a strong foundation for reducing shrimp disease losses to farmers, improving farm-level capacities and skills in shrimp health management, minimizing the risks of spread of shrimp diseases to other areas and improving shrimp farm productivity and profitability (MPEDA/NACA, 2003).

RISK MANAGEMENT

The risk management objective was to develop practical measures for containing/preventing shrimp disease outbreaks that should specifically cover identification of shrimp disease risk factors, diagnosis of problems and management strategies to control disease in farms. The results of the epidemiological study provided the basis for the project team to work closely with farmers and scientists to identify practical farm-level risk management interventions. Eventually two key areas were identified:

- Better management practices (BMPs) that are practical farm-level interventions to address the key “risk factors”. These were subsequently expanded to include all relevant shrimp disease risk factors, plus food safety and environmental risks.
- Farmer organization/self-help groups/clusters to address social and financial risks associated with farming and allow effective dissemination of the BMPs among group members.

The BMPs used were good pond preparation, good quality seed selection, water quality management, feed management, health monitoring, pond bottom monitoring, disease management, emergency harvest, harvest and post-harvest, food safety and environmental awareness. The BMPs were disseminated through communication channels involving farmer meetings, regular pond visits, training of extension workers and publication of ten brochures on steps of BMP adoption and booklets on shrimp health management and extension.

The BMPs were implemented through farmer groups and clusters, a cluster being a group of interdependent shrimp ponds situated in a specified geographical locality and typically being comprised of the farmers whose ponds are dependent on the same water source. The cluster concept makes it practical to communicate risks and risk management to farmers more effectively to reduce risks and maximize returns.

RISK COMMUNICATION

The risk management measures (BMPs) have to be simple and practical but science-based. Promoting their adoption requires an understanding of the farmers and their culture systems. Involvement of local institutions is also very important in this process. Communication with all stakeholders was therefore important in the promotion of BMP adoption by farmers in clusters.

Risk communication involved conducting training and demonstration of appropriate shrimp disease control measures, which should especially include demonstration of efficient farm management practices for containing viral and other diseases in selected farms through cooperation and self-help among shrimp farmers in affected areas.

A village demonstration programme for effective communication of risks, promoting adoption of risk management measures (BMPs) and capacity building of farmers was started in Mogalthur Village of West Godavari District of Andhra Pradesh during 2002, and has been very successful in forming a participatory movement of farmers across the country. The demonstration programmes were successful in organizing small-scale farmers into self-help groups for adoption of BMPs. The success of the village demonstration programme generated considerable enthusiasm among the aquaculture farming community, and there are now more requests from many quarters for conducting such programmes in the different regions of India. As a result, aquaclubs/aquaculture societies have been established in the maritime states for community management with a participatory approach (MPEDA/NACA, 2005.). In order to continue the work initiated by the MPEDA-NACA project and to provide the much needed thrust through institutional and policy changes to the extension work in coastal aquaculture development, MPEDA has established a separate agency, the National Centre for Sustainable Aquaculture (NaCSA), with the approval of the Government of India.

PROGRESS

The project has made significant progress, increasing from five farmers who adopted the cluster farm approach in 2001 to 730 farmers (813 ha) in 28 aquaclubs in five states (Andhra Pradesh, Karnataka, Orissa, Gujarat and Tamilnadu) in 2006 (Figure 2). The production of BMP shrimp through the programme has increased from 4 tonnes in 2001 to 870 tonnes in 2006. The success of the project led to the establishment of NaCSA in March 2007, which will facilitate links between aquaculture stakeholders, strengthen farmer societies and enable farmers to formulate common policies, strategies and voluntary guidelines.

LESSONS LEARNED

While not a formal risk analysis, the approach used by the project led to significant benefits to the participating farmers. The project reduced disease risks in cluster farms significantly. The prevalence of disease in the demonstration farms was reduced from 82 percent in 2003 to 17 percent in 2006 in Andhra Pradesh, while in non-demonstration ponds the reduction in disease prevalence was limited during the same period, as shown in Table 1 below.

Efficient use of resources such as feed, seed, fuel and finance resulted in minimizing the cost of production and maximizing profits. Compared to surrounding non-demonstration ponds, the crop highlights included:

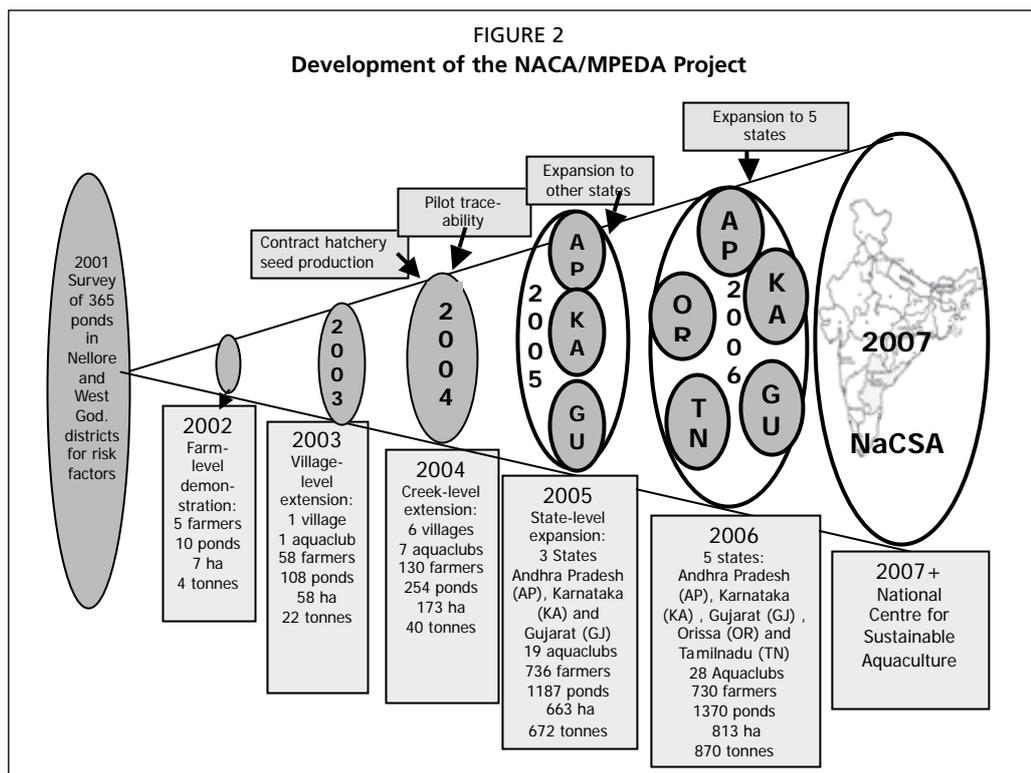


TABLE 1
Comparison of the prevalence (%) of disease in BMP and non-BMP shrimp ponds in from 2003 to 2006

Year	No. of BMP ponds	Disease prevalence in BMP ponds	No. of non-BMP ponds	Disease prevalence in non-BMP Ponds	Improvement
2003	108	82%	164	89%	+ 7%
2004	254	37%	187	52%	+20%
2005	1187	15%	517	42%	+27%
2006	1370	17%	901	44%	+27%

- 30 percent increase in production;
- 8 percent increase in size of shrimp;
- 30 percent improvement in survival; and
- 31 percent reduction in disease prevalence.

Economic analysis clearly demonstrates that farmers adopting BMPs have higher profitability and lower cost of production, and are able to produce quality and traceable shrimp without using any banned chemicals. In the demonstration ponds in Andhra Pradesh, for every Rs1000 (US\$25) invested by a farmer, around Rs520 (US\$13) was earned as profit in 2006. This was a substantial increase compared to the Rs250 (US\$6) profit made by non-demonstration farmers during the same period.

The programme led to reduction in other aquaculture-related risks. The environmental risks were also reduced by the decrease in pollution resulting from reduced use of chemicals, antibiotics and limited discharge of sediments and water exchange. Food safety risks were reduced substantially by discouraging the use of banned chemicals in cluster BMP ponds. Around 45 random shrimp samples from 29 clusters examined for the presence of banned antibiotics during the summer crop of 2006 tested negative. The shrimp produced in the demonstration farms were traced through a pilot-scale traceability programme in which the produce from a pond was identified by an eight digit number comprising State, District, Mandal, Village, Farm and Pond details. Based on backward linkage, the source of seed (including the mother prawn) was traceable and presently, work is underway to establish forward linkages with exporters.

The social impacts are reduction in risks to livelihoods and improved awareness of biosecurity and environment among cluster farmers.

SUSTAINING THE PROCESS

The risk analysis approach and the management measures adopted from the analysis show that BMPs and group management are promising models for farmers to work together to reduce disease, food safety, environmental, financial and social risks and earn their livelihood by helping the industry to meet customer demand through adoption of sustainable and environmentally friendly farming practices. The establishment of NaCSA is expected to further strengthen the BMP programme and give a boost to farmer societies. NaCSA will assist farmer societies to implement BMPs, participate in traceability and certification programmes and access premium international/domestic markets. The following steps are being taken by NaCSA to sustain the process:

Promoting BMPs to improve aquaculture productivity and profits

One of the most significant outcomes of the MPEDA/NACA project is the significant reduction in disease prevalence and improved productivity and profitability in aquaculture farms through adoption of BMPs. Successful implementation of BMPs reduced disease prevalence and increased the number of planned (normal) harvests, leading to better crop outcomes. NaCSA will continue to expand the process through formation of more self-help farmer societies and widespread promotion of BMPs through the aquaculture sector.

Capacity-building and empowerment of primary producers

Over the past five years the MPEDA/NACA village demonstration programme has contributed to significant awareness and capacity building among farmers in the aquaculture clubs. Increased interaction among farmers, improved community dialogue and more opportunities for mutual help has helped to create good will among farmers and enabled capacity building and empowerment. Cooperation among farmers and a collective approach has empowered farmers to obtain high-quality farm inputs (seed, feed, lime, etc.) at competitive prices. Cooperation and a collective approach have also enabled shrimp farmers to be more responsive to environmental concerns and forged strong unity in dealing with common problems (e.g. desilting of drains). NaCSA will continue to expand the process through formation of more self-help farmer societies in all the shrimp farming states of India.

Facilitating improved service provision to the sector

Provision of improved inputs to the sector through the facilitation of sector-servicing initiatives could help to further strengthen and sustain the industry. Such an initiative would encompass all forms of service including finance, microcredit, diagnostics, insurance, quality inputs, technical inputs, etc.

Connecting farmers to markets for realization of better price

NaCSA will work towards bringing processors and farmers together to improve harvest and post-harvest practices to further increase the quality of shrimp supplied to the processing plants and seek to obtain premium prices for farmers for quality product. NaCSA will work to explore opportunities for facilitating certification programmes and implement traceability schemes. Further, the implementation of BMPs by the farmers groups can result in better value realization for the products, which can also create a niche for such products in the global market. The branded products are value earners in the international market.

Food security and sustainable livelihoods

The development of coastal aquaculture in the country has enhanced the socio-economic condition of the rural communities. Direct as well as indirect employment opportunities have improved the livelihood condition in the villages. Through the formation of aquaculture societies, self-empowerment of farmers is also programmed. The ways and means to reduce the cost of production will be explored. Implementation of BMPs by an organized farming sector would contribute to food security and also ensure sustainable livelihoods for the small-scale farmers involved.

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